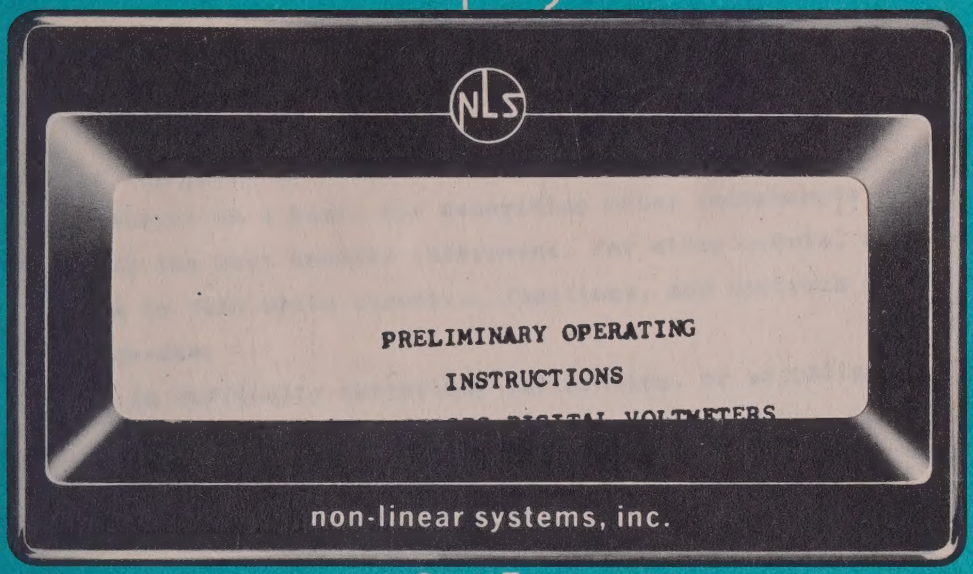
MPG RESEARCH LABORATORY
2345 Walnut Street
St. Paul, Minn. 55113



MODEL 4300

non linear systems, inc.

DEL MAR, CALIFORNIA

Herb Tregesser @ plant
Del Mar – 20 mi. N. of S/J

3/4/65 Chicago Office 312-889-1277

JACK HALE – NLS Tech Rep – 644-0585 (answering service only)
~~(Home 9-1-429-7404)~~

Model 4313
Part # 4963
Serial # 4313.51

Bill Lagna: 1 year warranty

Input Cable missing on arrival 6/8/64
Lowell Swanson (5009) donated one to us –

Jack Hale gave us one on 7/28/64 – we now have it as a spare.

PRELIMINARY OPERATING INSTRUCTIONS 4300 SERIES DIGITAL VOLTMETERS

NOTE:

When available, complete manuals will be sent to instrument users. In the meantime please contact the nearest NLS office if service information is required. A list of service centers is included.

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(Instrument topology is shown on page 15)

I

INTRODUCTION

Series 4300 Digital Voltmeters are low-cost all-electronic instruments whose characteristics are outlined in the specifications which follow. The Model 4318 serves as a basis for describing other instruments in the series because it is the most complex instrument. For other models, see the list in this section to find which circuits, functions, and controls mentioned are to be disregarded.

If there is difficulty operating, calibrating, or adjusting the instrument, contact an NLS service branch. Addresses are on page 4.

Specifications

Ranges:.....±9999/9.999/99.99/999.9 VDC

Accuracy:.....± (0.05% of reading + 0.01% of full scale), 40 to 120°F.

Speed:.....0.5 sec. reading time per range, or on manual range.

Input Resistance:.10 megohms at balance.

Polarity Change:..Automatic or manual.

Range Change:.....Automatic, fixed, manual, or remote -- depending upon model.

Ground Isolation:.Signal leads can be floated 1000 volts above outer case.

Common Mode Rejection:.....Exceeds 60 db at 60 cps with 1000 Ω input line unbalance.

Print Output:.....Decimal contact closures in parallel. 2421 code upon request.

AC Measurements:..Use NLS Model 1101, 1102, 1109, 1201 or 1204 AC-to-DC Converter. Accuracy is that of converter plus digital voltmeter.

Primary Power:....115/220, 50-60 cps, 50 watts, max.

Weight:.....25 lbs. net; 45 lbs. shipping (approximate).

Dimensions:.....5¼" high, 15¼" deep, 19" wide, for rack or bench.

Input Connector:..Front connector is normally supplied; rear connector on request.

NOTES:

1. The relation of these specifications to individual models is shown on page 3.
2. Specifications are subject to change.

4300 Series List of Models

MODEL	NUMBER OF		FUNCTION CONTROLS			
	DIGITS	RANGES	POL-ARITY	RANGE*	PRINTER CON-TACTS	REMOTE RANG-ING
4301	4	1	M	F		
4302	4	1	M	F	YES	
4303	4	1	A	F		
4304	4	1	A	F	YES	
4305	4	3	M	M		
4306	4	3	M	M	YES	
4307	4	3	A	M		
4308	4	3	A	M	YES	
4309	4	3	A	AM	YES	
4310	4	3	A	AM		
4311	4	3	A	AM	YES	YES
4312	4	4	M	M		
4313	4	4	M	M	YES	
4314	4	4	A	M		
4315	4	4	A	M	YES	
4316	4	4	A	AM	YES	
4317	4	4	A	AM		
4318	4	4	A	AM	YES	YES
4319	3	1	M	F		
4320	3	1	M	F	YES	
4321	3	1	A	F		
4322	3	1	A	F	YES	
4323	3	3	M	M		
4324	3	3	M	M	YES	
4325	3	3	A	M		
4326	3	3	A	M	YES	
4327	3	3	A	AM	YES	
4328	3	3	A	AM		
4329	3	3	A	AM	YES	YES
4330	3	4	M	M		
4331	3	4	M	M	YES	
4332	3	4	A	M		
4333	3	4	A	M	YES	
4334	3	4	A	AM	YES	
4335	3	4	A	AM		
4336	3	4	A	AM	YES	YES

*AM = Automatic and Manual Ranging
F = Fixed Range (single-range instrument)
M = Manual Ranging

NLS ENGINEERING/SERVICE CENTERS

Alabama, Huntsville
Suite 8, 2907 Governor St.
534-1077, Area Code 205

Arizona, Phoenix
2802 E. Shangri La
274-7008, Area Code 602

California, Del Mar
Box 728
755-1134, Area Code 714

California, San Jose
2858 Stevens Creek Blvd.
241-0200, Area Code 408

California, South Pasadena
1015 Fremont Avenue
682-3705, Area Code 213

California, Solvang
2681 Baseline
Santa Ynez 5272

Colorado, Littleton
709 W. Littleton Blvd.
798-6762, Area Code 303

Florida, Orlando
705 W. Colonial Drive
423-8901, Area Code 305

Illinois, Chicago
1915 N. Harlem Avenue
TUxedo 9-1277, Area Code 312

Louisiana, New Orleans
822 Perdido Street
525-4693, Area Code 504

Massachusetts, Waltham
235 Bear Hill Road
899-1430, Area Code 617
TWX 617-894-0748

Michigan, Detroit
26847 Grand River Avenue
531-1403, Area Code 313

Minnesota, Minneapolis-
St. Paul
1821 University Avenue
644-0585, Area Code 612

Missouri, Florissant
100 St. Francois Street
WAlnut 1-7666, Area Code 314

New Jersey, Caldwell
387 Passaic Avenue
228-2525, Area Code 201

New Jersey, Cherry Hill
1500 Kings Highway
HAzel 8-1663, Area Code 609

New Mexico, Albuquerque
265-4887, Area Code 505

New York, Jericho, L. I.
50 Jericho Turnpike
333-7020, Area Code 516
TWX 516-333-8548

New York, Poughkeepsie
21 Davis Avenue
471-0850, Area Code 914

New York, Rochester
75 College Avenue
244-0720, Area Code 716

North Carolina,Winston-Salem
722-1717, Area Code 919

Ohio, Dayton
3300 S. Dixie Drive
298-8638, Area Code 513

Oklahoma, Tulsa
7508 E. 28th Street
NA7-4988, Area Code 918

Pennsylvania, Monroeville
4105 Northern Pike Road
372-7858, Area Code 412

Texas, Dallas
8428 Kate Street
363-5533, Area Code 214
TWX 214-899-8051

Texas, Houston
P.O. Box 35007
MA3-1845, Area Code 713

Virginia, Arlington
1008 N. Randolph Street
524-4732, Area Code 703

Washington, Bellevue
208 Carlson Building
GL4-9332, Area Code 206
TWX 206-742-0834

EXPORT (Except Canada)

Frazar & Hansen Ltd.
150 California Street
San Francisco 11, Calif.
YUkon 1-5262, Area Code 415

HAWAIIAN ISLANDS

Kentron Hawaii, Ltd.
Honolulu, 512-781

CANADA

Contact the Seattle, Detroit or Jericho, L.I., centers. Each has full time field men who serve Canada.

MAIN OFFICE

Box 728
Del Mar, Calif.
755-1134, Area Code 714
TWX 714-377-3191

II

INSTALLATION AND OPERATION

1. UNPACKING

Instruments are shipped in two-piece polystyrene-bead containers. Cut tape between container halves and open. If damage is seen, promptly notify carrier. There is no packing material inside the instrument.

2. POWER SOURCE

The instrument is ready for operation from conventional 115-volt, 60-cycle power sources. A 220-volt source may be used if the two primaries of the power transformer are wired in series instead of in parallel. Schematic shows transformer pin numbers.

3. FUSING

A 3AG, 1 ampere slo-blo fuse in an extractor post on the rear panel protects the instrument. Use fuse specified.

4. POWER GROUNDING

Third pin on power plug grounds instrument. If using adapter, ground third pin with wire to outlet box or plate. Do not cut third pin.

5. CONTROLS

The number and type of front-panel controls used is determined by measuring capability. Since Model 4318 has more capabilities than other instruments in the series, a description of its controls suffices for other instruments.

The POWER switch has six positions:

OFF

AUTO - continuous readings at a rate regulated by the DISPLAY control.

MANUAL - displays and preserves a single reading.

MANUAL PRINT - records a single reading on an associated data recorder.

AUTO PRINT - records continuously. When a voltage measurement is completed, a print command is issued to the data recorder through N. O. contacts. The print complete signal initiates a new reading through Form C contacts located in the data recorder. See Figure 2-2.

RESET - a spring-return position. If the POWER switch is turned to this position and released, a new read-and-print command is initiated. If a data recorder is being used, it will finish, but the data will be erroneous if the RESET has been actuated while the recorder is recording a prior signal.

The RANGE switch has six positions:

REMOTE - external circuits range the instrument. See Section 7., Remote Operation.

AUTO - up to 1000 VDC is measured. The decimal point shifts as needed to provide correct readings.

1000V, 10V, and 1V - manual range settings.

- A Note About Polarity Indication -

The Model 4813 provides automatic polarity indication. Other 4300 Series polarity-control options are manual, for which a ± POLARITY switch is provided, and fixed, which requires that the measured voltage be applied with + to the red lead and - to the black. If the wrong polarity is applied to either a manual or fixed polarity instrument, the readout will display all zeroes.

The DISPLAY control adjusts the persistence of display from the minimum time listed in Specifications, Section I, to a maximum of no change. In the infinite, full clockwise position, a reading may be indefinitely stored in the presence of a fluctuating input. For this reason, the DISPLAY control effectively stabilizes readings when it is properly set short of infinity. This effect can be used to adjust the speed of the instrument to a data recorder if diode CR-6 is removed.

6. INPUT CONNECTION

Red is usually for signal high; black is usually for signal low. Readout polarity sign is + when signal on red is most positive. Blue is common with instrument chassis and should be connected to earth or system ground. If no earth or system ground exists (as with a floating battery), leave blue open.

7. REMOTE OPERATION

The ranging function may be controlled remotely by a single-pole, four-position switch, or equivalent circuit as part of an automatic program. For this function a 34-pin connector is provided on the rear panel. This connector is internally wired to reed relays which are physically outside of the high CMR guard area. Connections are made to the pins as follows:

VDC RANGE	PIN NO.	
1000	J	
100	K	(Pin L is common
10	H	for all ranges.)
1	M	

The relays operate on 12-15 VDC, polarity position is unimportant. Switching circuit is shown in Figure 2-1.

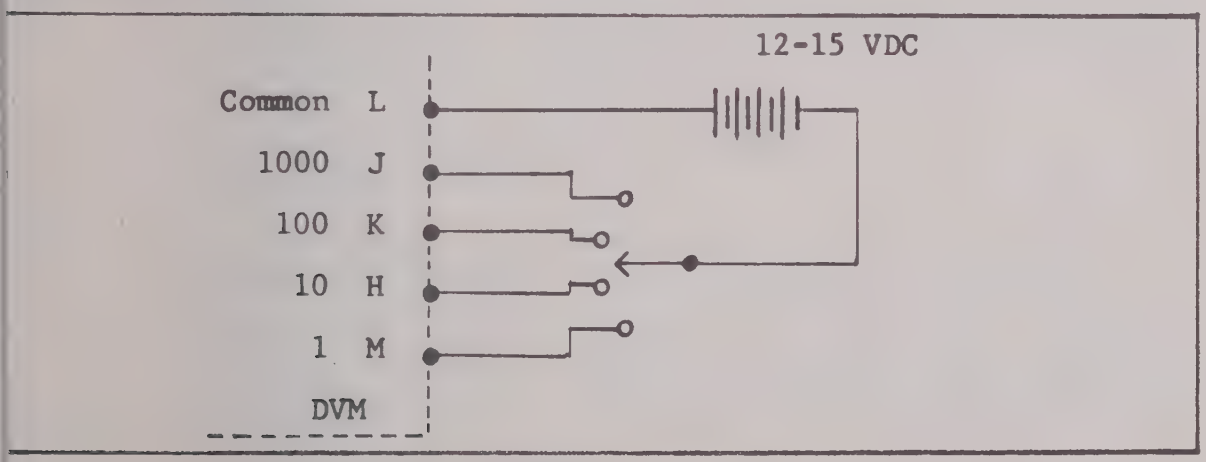


FIGURE 2-1.

REMOTE SWITCHING CIRCUIT

It is also possible to record data remotely if the recorder contains the correct print-complete circuit. This circuit is described under 5., Printer Operation. The digital voltmeter POWER switch must be set at AUTO PRINT.

8. PRINTER OPERATION

Connections to a data recorder,such as the NLS Model 155 Printer, are made through a 75-pin connector at the rear of the digital voltmeter. When a voltage is being displayed, appropriate reed relays in the instrument are energized, making available contacts to which a printer, remote readout, punch, or other device may be wired. These reed relays must not be connected to circuits which subject them to excessive switching current. The contact ratings for switching current are:

Maximum current - .5 ampere at 250 VDC

Maximum voltage - 400 VDC at .2 ampere

In addition to making connections for information to be printed, there is need for the printer to "know" when to start printing and for the digital voltmeter to "know" when the printer has finished its print cycle. Intelligence lines carrying this information are also connected to the 75-pin connector. A typical operating cycle is:

1. The DVM computes an input voltage.
2. The value of this voltage is displayed and appropriate reed contacts are closed.
3. A "print command" is issued by the DVM. This command is represented by the closing of two contacts to which the printer is connected.
4. The printer goes through its print cycle during the DVM display time.
5. At the end of the print cycle, the printer closes contacts which signal a "print complete" to the DVM.
6. The "print complete" signal is received by a relay in the DVM, closing a circuit which allows the instrument to again compute an input voltage - and the cycle is complete.

The following table and figure give the correct pin locations for all data recording functions:

DIGIT	UNIT *	TENS	HUNDREDS	THOUSANDS
0	11	14	10	13
1	17	21	16	20
2	24	27	23	26
3	30	33	29	32
4	36	39	35	38
5	42	45	41	44
6	48	51	47	50
7	54	57	53	56
8	60	64	59	63
9	67	72	66	71
Common	75	78	74	77

	PIN
DECIMAL FOR 1 VOLT max.	5
DECIMAL FOR 10 VOLT max.	2
DECIMAL FOR 100 VOLT max.	7
DECIMAL FOR 1000 VOLT max.	3

POLARITY SIGNS

+ Symbol Pin 18
- Symbol Pin 25
+,- Common Pin 12

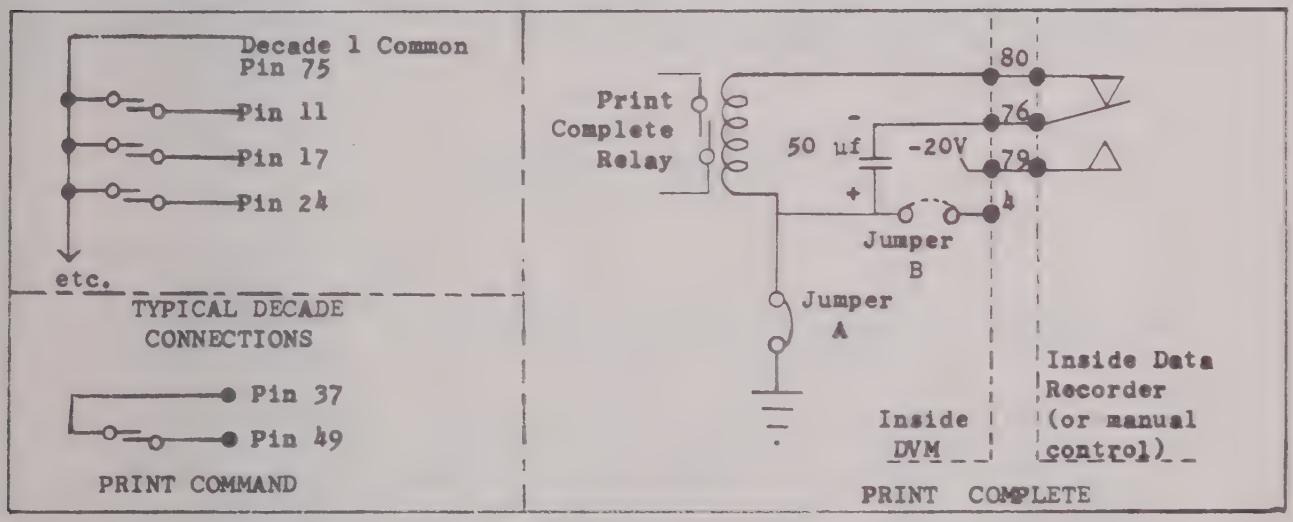


Figure 2-2. Printer Connections for Decades, Print Command, and Print Complete.
* The Units decade is not used with three-digit instruments.

The print-complete circuit is normally operated by an internal source of 20 volts, the negative side of which is at Pin 79. The contacts used inside of the data recorder (or any other external contacts), must be provided with 1000-volt insulation from earth ground.

If it is desired to operate the print-complete relay from an external voltage source, negative connection is made to Pin 80 and positive to Pin 4. Also, Jumper A is to be removed and Jumper B inserted. The physical location of these jumpers is shown on Figure 3-1B. When using an external voltage source, the value may be from 12 to 20 VDC; there is no requirement for 1000-volt insulation since internal DVM circuits are isolated by the print-complete relay.

III

CALIBRATION

When a 4300 Series instrument is not making readings within specifications, it is time for calibration, repair, or both. In the calibration information given in this section, the instrument is assumed to be in good working order and only in need of calibration. If there are any defective components, it may be difficult, if not impossible,to properly calibrate the instrument.

The calibration procedure is divided into three distinct areas: amplifier adjustment, reference voltage-supply adjustment, and ranging adjustment. It is important that these areas be taken as listed and that the steps in each area be followed in listed sequence.

EQUIPMENT NEEDED

The following are required:

1. Stable, but not necessarily precise, sources of 10, 100, and 1000 volts DC.

2. A decade voltage divider, such as the Dekavider, Model DV-411.

3. A bank of nine standard cells, such as the NLS P/N 3006.

4. A ratio box with precise divisions of 10:1 and 100:1, such as the NLS P/N 3020.

AMPLIFIER ADJUSTMENT

1. Turn on the voltmeter and allow it to warm up for at least 45 minutes with the top and bottom covers on.

2. Apply a known voltage which, in a properly calibrated voltmeter, would display a numeral 2 in the right-hand window. A value of .2 ± 10% may be used with the range set at 1000V; smaller values such as .02 or .002 are also satisfactory if the range is shifted to 100V or 10V, respectively.

3. Open the top outer cover and, through the hole in the inner cover, adjust R-109 to the full clockwise position. The physical location of R-109 is shown in Figure 3-1.

4. Through the other hole in the inner top cover, adjust R-127 clockwise until the polarity display begins to change from + to - with every scan; when this occurs, slowly rotate R-127 counterclockwise until a single polarity is displayed.

5. Change the value of the input voltage to .8, .08 or .008 & apply it in the manner described in Step 2 above.

6. Adjust R-109 to indicate 8 in the right-hand window.

7. Repeat Step 2. If the polarity indication remains stable, the amplifier adjustment procedure is complete; if the polarity sign is not stable, continue with Step 8.

8. Adjust R-127 to stabilize the polarity sign and repeat Steps 5, 6, and 7.

REFERENCE VOLTAGE ADJUSTMENT (STANDARDIZATION)

CAUTION

On four-range instruments, manually select the 10V range before connecting input leads to standard cells.

1. Connect the standard-cell bank to the input of the instrument. The black lead is connected to the negative terminal; the red lead is connected to the positive nine-volt end of the cell bank.

2. Adjust R-10 (fine adjustment) and, if necessary, R-11 (coarse adjustment) until the display reads correctly the value of the standard-cell bank. Pots R-10 and R-11 are accessible from the bottom of the instrument. It is necessary to remove the bottom outside cover and reach through holes in the inner cover; do not remove inner covers. The most convenient way to reach these adjustments is simply to place the digital voltmeter on its side when making the adjustments. See also Figure 3-1 for physical location.

RANGING ADJUSTMENTS

WARNING

THIS PROCEDURE REQUIRES THE USE OF DANGEROUSLY HIGH VOLTAGE. BE CAREFUL! ALSO OBSERVE WARNING ON TOP INNER COVER.

All ranging adjustments are made with the inner covers in place and with a positive potential applied to the red lead, negative to the black.

100-VOLT RANGE

1. Connect the input terminals of the ratio box to a stable, but not necessarily accurate source of 95 to 99 volts.

2. Set the ratio box at 10:1.

3. Also connect the input cable of the voltmeter to the input of the ratio box.

4. Set the digital voltmeter at the 100-volt range; record the value of the display.

5. Disconnect the voltmeter input cable from the input of the ratio box and reconnect it to the output of the ratio box.

6. Set the digital voltmeter to the 10-volt scale; record the value of the display.

7. If the reading recorded in Step 4 is the same as recorded in Step 6, except for decimal-point position, the 100-volt range is calibrated. Example: If, in Step 4, a value of 97.43 was recorded, then the value recorded in Step 6 must be 9.743. If this digital correspondence is present, Steps 8, 9, and 10 are to be eliminated; otherwise proceed with Step 8.

8. Set the digital voltmeter to the 100-volt range and move the input cable back to the input of the ratio box.

9. Adjust R-100 (through a hole in the top of the inner cover, as shown in Figure 3-1) until the reading digitally corresponds to the figure recorded in Step 6.

10. Set the digital voltmeter to the 10-volt range and move the input cable to the output of the ratio box. If digital correspondence is not present, repeat Steps 8, 9, and 10.

1000-VOLT RANGE

CAUTION

High voltage is required for this step.

1. Follow the same procedure as outlined in Steps 1 through 10 of the 100-Volt ranging adjustment except: set the ratio box to 100:1 and apply from 950 to 999 volts to the ratio box input. If digital correspondence is not present, adjust R-1000 (located just to the right of R-100). When finished, promptly remove high voltage.

FINAL ADJUSTMENTS

1. Return to the amplifier adjustment procedure steps and repeat. If, on this second check, the amplifier pots must be adjusted again, repeat both the reference supply adjustment procedure and the ranging adjustment procedure. This last step completes the calibration.

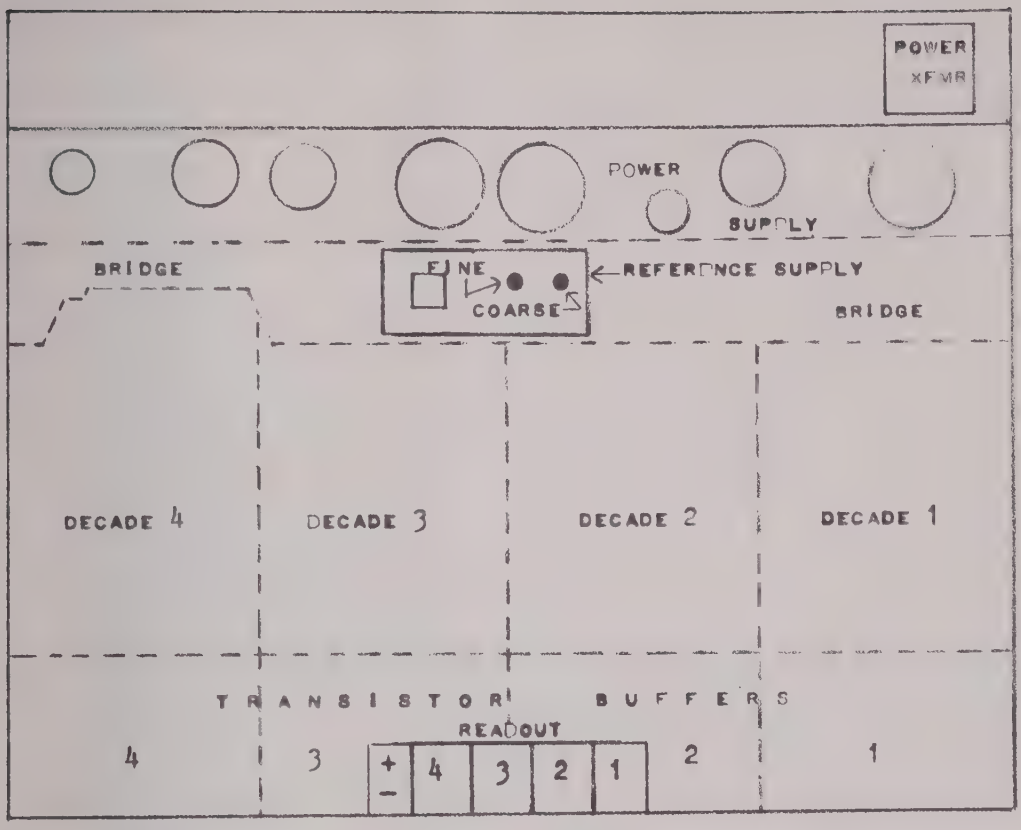


FIGURE 3-1A. FRONT VIEW FROM THE TOP, WITH HINGED BOARD REMOVED. 4300 SERIES DIGITAL VOLTMETER.

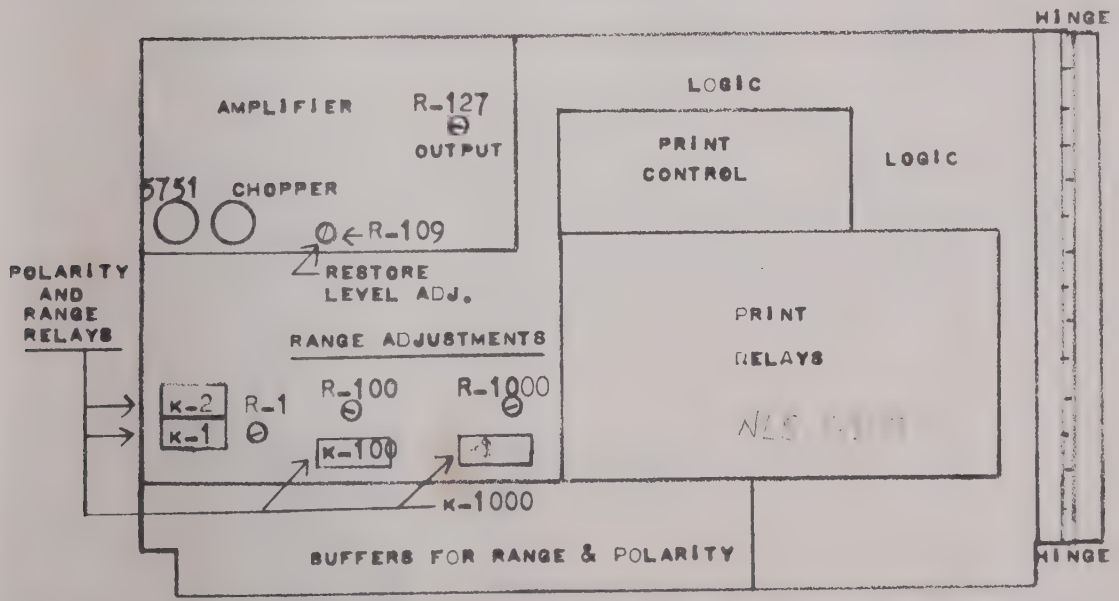
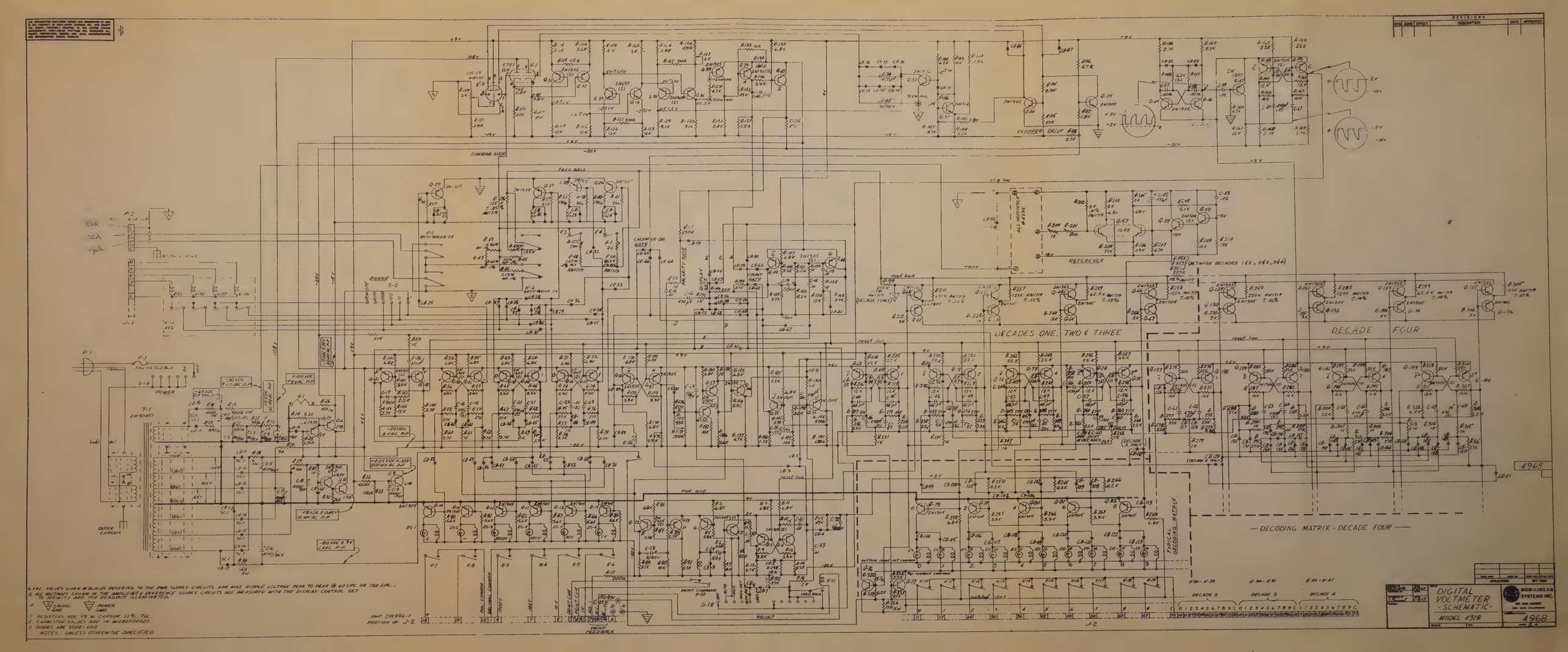


FIGURE 3-1B. FRONT VIEW OF THE TOP OF THE HINGED BOARD AS SEEN IN OPERATING POSITION. THE PRINTED CIRCUIT SIDE IS UP.


DECADES ONE, TWO & THREE
DECADE FOUR
— DECODING MATRIX - DECADE FOUR —
DIGITAL VOLTMETER -SCHEMATIC-
MODEL 4318
NON-LINEAR SYSTEMS INC.
1968
1969
REVISIONS
DESCRIPTION
DATE
APPROVED
RANGE
POWER
REFERENCE
CHOPPER DRIVE
SUMMING NODE
DECODING MATRIX
NOTES: UNLESS OTHERWISE SPECIFIED

MAINTENANCE RECORD (WITHIN WARRENTY)

19 NOV '64 Jack Hale replaced reed relay on panel within DVM for remote read-out head. (STUCK DIGIT) ...K-20

22 JAN '65 "5" in 2° pos'n from left STUCK ... K-35 ? — tapped board - OK

28 JAN '65 "6" in 2° pos'n from right STUCK ...K-26 — tapped board - OK

4 MAR '65 AUTO POLARITY MODIFICATION RETROFIT — SY 777 890
P.S.O. 5-00719 F. O'Neill —— Sent Air —

non linear
systems, inc.

DEL MAR, CALIFORNIA

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